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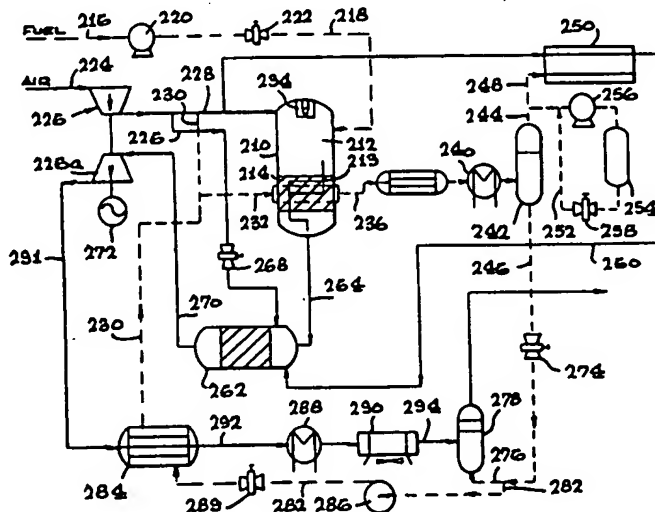
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(21) International Application Number: PCT/US99/05238 (22) International Filing Date: 10 March 1999 (10.03.99) (30) Priority Data: 60/077,733 12 March 1998 (12.03.98) US (71) Applicant: HYDROGEN BURNER TECHNOLOGY, INC. (US/US); 3925 Vernon Street, Long Beach, CA 90815 (US). (72) Inventor: WOODS, Richard, R.; 3925 Vernon Street, Long Beach, CA 90815 (US). (74) Agent: ABRAHAM, Colin, P.; Suite 400, 5850 Canoga Avenue, Woodland Hills, CA 91367 (US).	(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published With international search report. (88) Date of publication of the international search report: 10 February 2000 (10.02.00)	

(54) Title: PROCESS GAS PURIFICATION AND FUEL CELL SYSTEM



(57) Abstract

A module (214 Fig. 5) for separating a product from a mixed stream comprises a mixed stream chamber having inlet and outlet means and defining a first flow path for the mixed stream, a purge/product stream chamber having inlet and outlet means and defining a second flow path for a purge/product stream, the second flow path having a substantially countercurrent direction to that of the first flow path, and a membrane located between the mixed stream chamber and the purge/product stream chamber, the membrane being selectively permeable to the product. There is also disclosed a fuel cell system comprising a burner module (210) for mixing and combusting a fuel and air mixture to produce hydrogen rich fuel stream; a hydrogen fuel cell (250) for producing power/energy using the hydrogen fuel produced by the burner module; a hydrogen purification module (214) between the burner module and the fuel cell for extracting hydrogen fuel from the burner module for use in the fuel cell and that uses a purge gas to enhance purification module performance; hydrogen storage means (254) for storing hydrogen fuel produced by the burner module and not immediately required by the fuel cell; and means for feeding stored hydrogen fuel from the storage means to the fuel cell when the hydrogen requirements of the fuel cell are greater than the amount of hydrogen produced in the burner module.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/05238

A. CLASSIFICATION OF SUBJECT MATTER IPC 6 B01D53/22 B01D53/32 H01M8/06 C01B3/50		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 6 B01D H01M C01B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 562 754 A (KANG DOOHEE ET AL) 8 October 1996 (1996-10-08) column 7, line 44 -column 9, line 41; figure 2	1-4,6, 18-21, 25,28
X	--- EP 0 615 949 A (TOKYO GAS CO LTD ;MITSUBISHI HEAVY IND LTD (JP)) 21 September 1994 (1994-09-21) the whole document	1-4,6, 18,20, 21,25,28
A	--- GB 990 131 A (ENGELHARD INDUSTRIES INC.) 28 April 1965 (1965-04-28) page 1, column 1, line 11 - line 33 page 2, line 4 - line 8 page 3, line 101 - line 109 --- <div style="text-align: right;">-/-</div>	1-3,20, 21,28
<div style="display: flex; justify-content: space-between;"> <input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex. </div>		
<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>** document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search <div style="text-align: center; font-weight: bold;">8 July 1999</div>		Date of mailing of the international search report <div style="text-align: center; font-weight: bold;">26.11.99</div>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer <div style="text-align: center; font-weight: bold;">Borello, E</div>

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/05238

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 612 012 A (SOMA TAKAO ET AL) 18 March 1997 (1997-03-18) abstract; example 2 ---	1,20
A	GB 2 283 235 A (ROLLS ROYCE & ASS) 3 May 1995 (1995-05-03) abstract; figure 1 -----	1,20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/05238

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4, 6, 18, 19-21, 25, 28, 29

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-4,6,18,19-21,25,28,29

"A module and method for the purification of a product using a membrane and a condensable gas purge at the permeate side"

INDEPENDENT CLAIM 1 and its
DEPENDENT CLAIMS: 2,3,4,6,18,19
INDEPENDENT CLAIM 20 and its
DEPENDENT CLAIMS: 21,25,28,29

Problem to be solved:

To purify a product with a membrane, using a sweep medium on the permeate side and to separate it from the product.

Solution:

To use a condensable gas

2. Claims: 1,5

"A module and method for the purification of hydrogen using the juxtaposition of a membrane with permeate side purging and a partial oxidation reformer as the source for the hydrogen containing mixed gas"

INDEPENDENT CLAIM 1 and its
DEPENDENT CLAIM: 5

Problem to be solved:

To provide a mixed gas to produce purified hydrogen.

Solution:

To use a partial oxidation reformer.

3. Claims: 1,7,8,20,21,26,27,30

"A module and method for the purification of hydrogen using a diffusion membrane with permeate side purging"

INDEPENDENT CLAIM 1 and its
DEPENDENT CLAIMS: 7,8
INDEPENDENT CLAIM 20 and its
DEPENDENT CLAIMS: 21,26,27,30 (as far as referred to the diffusion membrane)

Problem to be solved:

To separate the hydrogen from a gas mixture.

Solution:

To use a hydrogen diffusion membrane.

4. Claims: 1,9-13,20,21,23,24,30,45,46

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

"A module and method for the purification of hydrogen using a ion conducting membrane with permeate side purging"

INDEPENDENT CLAIM 1 and its

DEPENDENT CLAIMS: 9 (partially as far as referring to the ion conducting membrane), 10,11,12,13

INDEPENDENT CLAIM 20 and its

DEPENDENT CLAIMS: 21,23,24,30 (partially as far as referred to the ion conducting membrane)

INDEPENDENT CLAIM 45: (partially: as far as referred to the method using a ion conducting membrane)

DEPENDENT CLAIM 46

Problem to be solved:

To separate the hydrogen from a gas mixture.

Solution:

To use a ion conducting membrane.

5. Claims: 1,9,14,15,20,21,23,24,30,45,46

"A module and method for the purification of hydrogen using a mixed ion and electron conducting membrane with permeate side purging"

INDEPENDENT CLAIM 1 and its

DEPENDENT CLAIMS: 9 (partially as far as referring to the mixed ion and electron conducting membrane), 14,15

INDEPENDENT CLAIM 20 and its

DEPENDENT CLAIMS: 21,23,24,30 (partially as far as referred to the mixed ion and electron conducting membrane)

INDEPENDENT CLAIM 45: (partially: as far as referred to the method using a mixed ion and electron

conducting membrane)

DEPENDENT CLAIM 46

Problem to be solved:

To separate the hydrogen from a gas mixture.

Solution:

To use a mixed ion and electron conducting membrane.

6. Claims: 1,16,17

"A module and method for the purification of a product using a membrane with permeate side purging and a catalyst for the CO shift reaction"

INDEPENDENT CLAIM 1 and its

DEPENDENT CLAIMS: 16,17

Problem to be solved:

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

To separate the product from a gas mixture and increase its concentration.

Solution:

To use a catalyst suitable for the CO shift reaction.

7. Claims: 20,22

"A module and method for the purification of a product using a membrane with permeate side purging and a higher pressure on the permeate side"

INDEPENDENT CLAIM 20

DEPENDENT CLAIMS: 22

Problem to be solved:

The tightness and the seal of the membrane to prevent the contamination of the high purity permeate gas by leakage from the feed/retentate side.

Solution:

To operate the permeate chamber at a higher pressure than the feed/retentate chamber.

8. Claims: 31-44

"A fuel cell system comprising: burner, hydrogen fuel cell, hydrogen purification module with permeate side purging"

INDEPENDENT CLAIM 31 (Device)

DEPENDENT CLAIMS: 32-38

INDEPENDENT CLAIM 39 (Process)

DEPENDENT CLAIMS: 40-44

Problem to be solved:

To set up and operate an integrated fuel cell system.

Solution:

To use a burner, a hydrogen purification module and a fuel cell.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern 1st Application No

PCT/US 99/05238

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5562754 A	08-10-1996	EP 0747109 A	11-12-1996
EP 0615949 A	21-09-1994	JP 6263402 A	20-09-1994
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GB 2283235 A	03-05-1995	NONE	

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